

REMARKS/ARGUMENTS

The Pending Claims

Claims 1-38 currently are pending and subject to examination.

Amendments to the Claims

The claims have been amended to point out more particularly and claim more distinctly the invention. Claims 1 and 33 have been amended to specify that the filled resin system comprises an aggregate. These amendments are supported by the specification at, for example, page 3, lines 19-20. In addition, dependent claims 8, 9, and 10 have been amended to be consistent with amended claim 1. Claim 34 has been amended to correct a formal matter regarding the claim language.

No new matter has been added by way of these amendments.

The Office Action

Claims 1-38 have been rejected under 35 U.S.C. § 103(a) as allegedly obvious over U.S. Patent 3,810,337 (Pollard) in view of U.S. Patent 6,123,485 (Mirmiran et al.), U.S. Patent 5,253,458 (Christian), U.S. Patent 5,508,072 (Andersen et al.), U.S. Patent 5,952,053 (Colby), and U.S. Patent 2,925,831 (Welty et al.). Reconsideration of these rejections is respectfully requested in view of the claim amendments and remarks herein.

Discussion of Claims 2 and 32

The Office contends that the terms “pultruded” and “pre-stressed” recited in claims 2 and 32, respectively, refer to product-by-process language.

Applicant respectfully maintains that the terms “pultruded” and “prestressed” should be properly construed as structural limitations and not as process limitations. If the Office’s interpretation of the terms “pultruded” and “prestressed” were applied to all such claim limitations, it would be impossible to draft meaningful claims. For example, if the term

“isolated” were viewed as a product-by-process limitation, molecules isolated from nature would be anticipated by the environment from which they were isolated.

The effect of a product-by-process limitation is best illustrated by examining the field of semiconductors. It is possible to produce semiconductors with the exact same structure by two different processes. In such a situation, it is not possible to place the first semiconductor produced by the first process next to the second semiconductor produced by the different second process and point to a structural difference between the two semiconductors. However, this is not the situation with a pultruded fiber composite member or a prestressed steel member, as recited in claims 2 and 32, respectively. Rather, if a pultruded member is placed next to an extruded member, one of ordinary skill in the art can point to the pultruded member on the basis of its structural differences. The same is true for the prestressed steel member. Accordingly, the claim limitations of “prestressed” and “pultruded” are physical characteristics that are inherent in the product and are not process limitations.

In view of the foregoing, Applicant respectfully submits that the terms “pultruded” and “prestressed” are valid structural modifiers of the claimed product which impart a further structural limitation to the claims.

Discussion of Rejections Under U.S.C. § 103(a)

For subject matter defined by a claim to be considered obvious, the Office must demonstrate that the differences between the claimed subject matter and the prior art “are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” 35 U.S.C. § 103(a); see also *Graham v. John Deere Co.*, 383 U.S. 1, 148 U.S.P.Q. 459 (1966). The ultimate determination of whether an invention is or is not obvious is based on certain factual inquiries including: (1) the scope and content of the prior art, (2) the level of ordinary skill in the prior art, (3) the differences between the claimed invention and the prior art, and (4) objective evidence of nonobviousness. *Graham*, 383 U.S. at 17-18, 148 U.S.P.Q. at 467.

Consideration of the aforementioned *Graham* factors here indicates that the present invention, as defined by the pending claims, is unobvious in view of the cited references.

1. *Scope and Content of the Prior Art*

As regards the scope and content of the prior art, both Pollard and Christian have been cited by the Office as primary references in support of the obviousness rejections. Mirmiran et al., Andersen et al., Colby, and Welty et al. have been cited by the Office as secondary references in support of the obviousness rejections in an effort to remedy the deficiencies of Pollard and Christian.

Pollard discloses a structural member in which reinforcing members (30) and (32) are surrounded by a lightweight void-containing material (38) (see, e.g., Figure 3). Pollard discloses that the lightweight void-containing material, in its final condition, adheres and bonds to the inner surfaces of side (10 and 12), bottom (14), and top (16) skin sheets (see, e.g., column 2, lines 45-47). The lightweight void-containing material is injected into the structural member as a liquid foamable mass such that after foaming the interlocks (18) of the skin sheets are further secured by a thin film of plastic “glue” (see column 2, lines 47-52).

The Office alleges that Mirmiran et al. discloses a fiber composite tubular member with reinforcing members and a cured substance. The structural member disclosed in Mirmiran et al. has a fiber reinforced plastic composite exterior shell, a cement core, and interior protruding fiber reinforced plastic portions.

Christian discloses simulated logs which are PVC pipes filled with foam insulation that is formed around a steel beam. The foam insulation may be either a dilite or bead type foam (see, e.g., column 3, lines 37-38) and clearly lacks an aggregate.

Andersen et al. allegedly discloses a polyurethane panel with light and heavy aggregates. The disclosure of Andersen et al. is directed to the technology of containers, such as fast food containers (see, e.g., abstract and column 1, lines 42-49). As such, Andersen et al. merely discloses light and heavy aggregates that may be mixed with packaging materials such as paper, paperboard, plastic, and polystyrene.

Colby discloses a process for producing filled polyurethane elastomers. The polyurethane compositions disclosed in Colby additionally may comprise diluents, compatibilizers, thixotropes, pigments and anti-settling agents (see, e.g., column 4, lines 33-35).

The disclosure of Welty et al. relates to the fabrication of composite surfaces and structures. Welty et al. discloses that a clean and roughened substrate surface is necessary in the fabrication process in order to ensure the best results (see, e.g., column 3, lines 23-35).

2. *Level of Ordinary Skill in the Art*

For the purposes of the present argument, one of ordinary skill in the art can be treated as someone with an advanced degree and/or at least a few years of experience in a field relevant to the invention.

3. *Differences Between Claimed Invention and Prior Art*

The present invention is directed to a hybrid structural module, as defined by amended independent claim 1, and a method of forming the same, as defined by amended independent claim 33. Specifically, the hybrid structural module recited in the pending claims comprises:

- (1) a tubular fibre composite member;
 - (2) a filled resin system comprising an aggregate, wherein the filled resin system is located within the tubular fibre composite member; and
 - (3) at least one elongated steel member located within the filled resin system;
- wherein the filled resin system binds the steel member and tubular member together.

In other words, the hybrid structural module recited in the pending claims requires three primary elements: a tubular fiber composite member, a filled resin system comprising an aggregate, and an elongated steel member.

Pollard discloses a structural member in which reinforcing members (30) and (32) are surrounded by a lightweight void-containing material, which in its final condition adheres and bonds to the inner surfaces of side (10 and 12), bottom (14) and top (16) skin sheets. The Office acknowledges that Pollard does not disclose a tubular fiber composite member. Pollard also does not disclose or suggest a filled resin system comprising an aggregate, as recited in the pending claims. Rather, Pollard discloses a *void-containing* core that is distinct from a filled resin system comprising an aggregate. Specifically, the void-containing core disclosed in Pollard would not be able to achieve the same structural properties of the filled resin system recited in the pending claims, such as increase in overall load carrying capacity, improved anti-crack behaviour, and decreased creep, as discussed in more detail below.

According to Pollard, the tensioning or stressing of the reinforcing members is through an end cap at each end of the beam (see, e.g., column 2, lines 42-45). In contrast, force transfer from the steel bars in the hybrid structural module recited in the pending claims is through the filled resin system and occurs along the total length of the element. The structural differences between the invention recited in the pending claims and the teachings of Pollard are easily demonstrated by cutting the structural elements in half (lengthwise). When Pollard's element is cut in half, it ceases to function as a structural element because the steel bars are no longer anchored at two ends and, therefore, can no longer be stressed. A "lightweight void containing core" is unable to transfer any significant force between the steel bars and the skin. In contrast, the hybrid structural module recited in the pending claims can be cut into two or more pieces lengthwise, and each piece will continue to function as a hybrid module due to its continuous force transfer along its length.

In addition, the hybrid structural module recited in the pending claims can be used in both tension and compression with equally good performance. In other words, the force transfer between the different elements in the claimed hybrid structural module is the same under tension and compression. In contrast, the structural element taught by Pollard has a completely different reaction under tension than in compression. In fact, the structural member disclosed in Pollard is severely limited under compression. In the unloaded state, the steel reinforcing bars of the element disclosed in Pollard are under tension due to the prestress introduced by tensioning the nuts of the steel bars. However, when the member is loaded in compression, the tensile force in the steel bars will slowly reduce to a point where the steel reinforcement bars are no longer in tension and are loaded in compression. As a result of the limited stiffness of the void-containing foam of the structural element disclosed in Pollard, it is highly likely that this will result in buckling of these reinforcement bars.

Consequently, the structural member disclosed in Pollard has a significantly different behavior in tension and compression. In particular, the relative load sharing between the different elements in the structural member disclosed in Pollard varies constantly depending on the loading on the column. The effect is most pronounced in compression, when the steel bar will cease to function as soon as the compression force in the steel bars becomes larger than the prestress force. In contrast, the hybrid structural module recited in the pending

claims advantageously acts the same in tension and compression, independent of the load level and, as such, can be confidently used in structures with changing load directions.

The structural member disclosed in Mirmiran et al. has a fiber reinforced plastic composite exterior shell, a cement core, and interior protruding fiber reinforced plastic portions. The disclosure of Mirmiran et al. is directed solely to the use of a concrete composite structure having a cement core. In contrast, the invention recited in the pending claims comprises a filled resin system comprising an aggregate that binds the steel member and tubular member together, which, importantly, makes the steel bar and the tubular fiber composite member work together as one structural unit.

The main function of the composite wrap disclosed in Mirmiran et al. is to provide a water proof shell, while at the same time adding confinement to the concrete core (see, e.g., column 1, lines 61-63, and column 6, lines 26-33). Confinement increases the load carrying capacity of concrete in compression, bending, and shear (not tension). A concrete column loaded in compression wants to expand in cross sectional direction due to Poisson's action. By preventing or restraining this cross sectional expansion, the column is put in a three dimensional state of compressive stress and is able to carry more load. However, if the column is loaded in tension, the cross section gets smaller, and the fiber composite wrap ceases to work.

Because bending and shear are both accompanied by compression, the system disclosed in Mirmiran et al. also works partly in those cases. However, the composite wrap has hardly any effect in pure tension. Therefore, a significant difference between the structural member disclosed in Mirmiran et al. and the invention recited in the pending claims is that the structural member disclosed in Mirmiran et al. does not work as well in tension as in compression.

In addition, the structural member of Mirmiran et al. has significant disadvantages when loaded in tension, because, without prestressing, concrete loaded in tension will crack. In contrast, a filled resin system comprising an aggregate has excellent tensile properties and can be loaded in tension as well as compression.

Christian discloses PVC pipes filled with foam insulation that is formed around a steel beam. As acknowledged by the Office, Christian does not disclose or suggest a fiber composite member or a filled resin system comprising an aggregate. The Office alleges that the combined disclosures of Pollard and Mirmiran et al. compensate for the deficiencies of Christian. However, as discussed above, neither Pollard nor Mirmiran et al. discloses a filled resin system comprising an aggregate, much less a hybrid structural module wherein such a filled resin system binds a steel member and tubular member together.

Similar to Pollard, Mirmiran et al., and Christian, Andersen et al. also does not disclose or suggest a filled resin system comprising an aggregate, much less the use of the same for a hybrid structural module, as recited in the pending claims. In contrast to the pending claims, Andersen et al. is directed to the distinctly different technology of containers, such as fast food containers (abstract and column 1, lines 42-49), and merely discloses light and heavy aggregates that may be mixed with packaging materials, such as paper, paperboard, plastic, and polystyrene.

Andersen et al. teaches dispersing aggregates in organic binders, such as polysaccharides, proteins, and synthetic organic binders including polyvinyl pyrrolidone, polyethylene glycol, polyvinyl alcohol, polyvinylmethyl ether, polyacrylic acids, polyacrylic acid salts, polyvinyl acrylic acids, polyvinyl acrylic salts, polyacrylimides, ethylene oxide polymers, polylactic acid, and latex. These binders clearly are distinct from the resin systems disclosed in the present application.

As mentioned above, Andersen et al. is directed to sheet materials for the mass-production of food and beverage containers. The sheet materials disclosed in Andersen et al. are clearly described as having properties substantially similar to conventional paper, plastic, or metal sheets (see, e.g., abstract). Elsewhere, the aggregate materials disclosed in Andersen et al. are described as increasing tensile and compressive strength, modulus of elasticity, and elongation. However, these properties are described in relation to mass-produced food and beverage containers and not in relation to structural modules, as evidenced, for example, at column 7, lines 8-14, of Andersen et al. where the sheet materials are described as having properties similar to those of paper, plastic, or think-walled metals, and which are suitable for forming packaging materials such as containers. In view of the foregoing, when Andersen et

al. describes that adding an aggregate increases strength, this is merely with respect to packaging materials and not with respect to structural engineering.

Furthermore, the sheet materials disclosed in Andersen et al. will readily degrade into a fine granular powder when exposed to moisture, pressure, and other environmental forces (see column 10, lines 22-32). Therefore, the sheet materials disclosed in Andersen et al. could not be used in the manufacture of a hybrid structural module, which must resist the aforementioned types of forces in order to provide a reliable structural building material.

The Office relies on Colby as allegedly disclosing the addition of a thixotrope to a resin. Similarly, the Office relies on Welty et al. as allegedly disclosing cleaning and roughening a structural member. Neither Colby nor Welty et al. discloses or suggests a filled resin system comprising an aggregate, much less a hybrid structural module comprising the same, as recited in the pending claims. Accordingly, the disclosures of Colby and Welty et al. do not compensate for the deficiencies of the other cited documents.

In summary, the invention defined by the amended claims comprises a filled resin system comprising an aggregate, which is readily distinguishable from the void-containing materials, foams, and polymers disclosed in the aforementioned references cited by the Office.

4. Objective Evidence of Unobviousness

The invention recited in the pending claims combines three primary elements: an elongated steel member, a filled resin system comprising an aggregate, and a tubular fiber composite member, each having a different failure behavior. This novel and inventive combination advantageously builds redundancy into the hybrid structural element. As a result, it is extremely unlikely that the three components of the claimed module will fail at the same time (see the specification at page 8, lines 11-17). Additionally, if one of the three components develops a crack, the crack is unlikely to extend into the other components. This is because cracks have a tendency to follow the interface of different materials, rather than travelling straight through them (see the specification at page 8, lines 18-22). A further advantage of a filled resin system comprising an aggregate is that if a crack does appear, the crack will be less likely to lengthen because the crack will not be able to continue when it encounters the aggregate.

Importantly, as recited in independent claims 1 and 33, the filled resin system comprises an aggregate that binds the steel member and the tubular member together. This has the advantage of making the steel bar and the tubular fiber composite member work together as one structural unit. Furthermore, the aggregate reduces the shrinkage of the resin system, which increases the adhesion provided by the filled resin system. As a result, the invention recited in claims 1 and 33, and claims depending thereon, is a synergistic hybrid member in which the overall load carrying capacity is surprisingly more than the mere sum of the individual members.

Another advantage of a filled resin system comprising an aggregate is that creep of the resin is reduced as compared to a resin lacking aggregate. With reduced creep, the resin is better able to bind the steel member and tubular member together than would otherwise be possible.

Applicant has unexpectedly discovered the synergistic increase in overall load carrying capacity, improved anti-crack behavior, and decreased creep of the hybrid structural module recited in the pending claims. In view of the potential for catastrophe if a structural element fails, the increased overall load carrying capacity of the invention defined by the amended claims is of great advantage and has the potential to avoid collapse of buildings and dwellings which might otherwise place many lives at risk.

In addition, a filled resin system comprising an aggregate costs less than the resin alone. Therefore, inclusion of the aggregate, which is less expensive than the resin, reduces the overall cost of filling the tubular member and binding it with the steel member.

There is nothing in the cited references which would have reasonably suggested to one of ordinary skill in the art that the physical features that define the present invention, especially the three primary elements discussed above, would be expected to impart the aforementioned superior properties to a hybrid structural module.

5. Consideration of Graham Factors Together

As set forth above, the invention recited in the pending claims requires the novel feature of a filled resin system comprising an aggregate, which is not disclosed or suggested by any of the cited references, either alone or in combination. Therefore, even when the

disclosures of Pollard, Mirmiran et al., Christian, Andersen et al., Colby, and Welty et al. are considered together, there is no disclosure of all of the features of the present invention. Instead, a combination of elements taught by the prior art would result in an inferior structural module that lacks the advantageous properties of the invention recited in the pending claims. In view of this glaring deficiency, the invention recited in the pending claims is clearly not the result of combining known elements to achieve a known result.

“When determining whether a claim is obvious, an examiner must make ‘a searching comparison of the claimed invention – *including all its limitations* – with the teaching of the prior art.’ *In re Ochiai*, 71 F.3d 1565, 1572 (Fed. Cir. 1995) (emphasis added). Thus, ‘obviousness requires a suggestion of all limitations in a claim.’ *CFMT, Inc. v. Yieldup Intern. Corp.*, 349 F.3d 1333, 1342 (Fed. Cir. 2003) (citing *In re Royka*, 490 F.2d 981, 985 (CCPA 1974)). Moreover, as the Supreme Court recently stated, ‘*there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.*’ *KSR Int’l v. Teleflex Inc.*, 127 S. Ct. 1727, 1741 (2007) (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) (emphasis added)).” *Ex parte Wada and Murphy*, Appeal No. 2007-3733 (USPTO BPAI, January 14, 2008), slip op. at page 7.

Here, the Examiner has provided no credible reason why one of ordinary skill in the art would further modify the combined disclosures of Pollard, Mirmiran et al., Christian, Andersen et al., Colby, and Welty et al. so as to prepare a hybrid structural module comprising a tubular fibre composite member, a filled resin system comprising an aggregate, and an elongated steel member, wherein the filled resin system binds the steel member and tubular member together, as required by the pending claims.

As discussed above, and contrary to the assertions of the Office, one of ordinary skill in the art would not have sought to modify the combined disclosure of Pollard and Mirmiran et al. to include an aggregate used in food and beverage containers, as disclosed in Andersen et al., in a hybrid structural module. On the contrary, one of ordinary skill in the art would recognize that aggregates that are used in the comparatively flimsy area of packaging materials and which are known to readily degrade are not suitable for use in a hybrid structural module.

Moreover, even if one of ordinary skill in the art were to use the synthetic organic binder comprising an aggregate, as disclosed in Andersen et al., in either of the structural members disclosed in Pollard, Mirmiran et al., or Christian, or any combination thereof, neither the claimed hybrid structural module nor the synergistic advantages thereof would be achieved because the feature of a filled resin system comprising an aggregate is not taught or suggested by any of the cited documents.

Indeed, even if one of ordinary skill in the art were to prepare a structural member based on the combined disclosures of Pollard, Mirmiran et al., and/or Christian, the result would be either (a) an exterior filament wound shell surrounding insulating foam and a steel beam, (b) PVC pipe surrounding concrete and protruding fibers, or (c) a PVC pipe surrounding a void-containing core and reinforcing members. These combinations clearly are distinct from the claimed invention and would not achieve the synergistic properties of the hybrid structural module recited in the pending claims.

The lack of any credible reason for making the necessary further modifications to the structural member to arrive at the present invention suggests that the obviousness rejection is premised on the hindsight knowledge of the present invention. Of course, it is improper and impermissible to utilize hindsight knowledge of an invention in considering whether the invention would or would not have been obvious to one of ordinary skill in the art at the time of the invention. See, e.g., *In re Dembiczak*, 175 F.3d 994, 999, 50 U.S.P.Q.2d 1614, 1617 (Fed. Cir. 1999) (“Measuring a claimed invention against the standard established by section 103 requires the oft-difficult but critical step of casting the mind back to the time of invention, to consider the thinking of one of ordinary skill in the art, guided only by the prior art references and the then-accepted wisdom in the field.”); see also *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1553, 220 U.S.P.Q. 303, 313 (Fed. Cir. 1983) (warning of the danger of “fall[ing] victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher”).

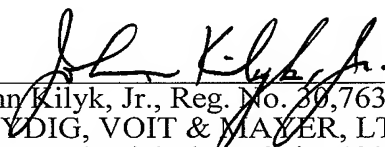
In view of the failure of the cited references – even in combination – to disclose or reasonably suggest all of the features of the present invention, the lack of any credible reason for one of ordinary skill in the art to make further modifications to a structural member prepared in accordance with the cited references so as to provide the present invention, and

the synergistic and unexpected properties of the present invention as compared to the conventional structural members disclosed in the cited references, the present invention as defined by the pending claims must be considered to have been unobvious in view of any combination of Pollard, Mirmiran et al., Christian, Andersen et al., Colby, and Welty et al. Accordingly, each of the obviousness rejections set forth by the Examiner should be withdrawn.

Conclusion

Applicants respectfully submit that the patent application is in condition for allowance. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,



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